FISH & RICHARDSON P.C.

601 Thirteenth Street N.W.
Washington, DC 20005

Telephone
202 783-5070

Facsimile
202 783-2331

Web Site
www.fr.com

May 19, 1999

By Hand Delivery

Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
The Portals TW-A325
445 12th Street, SW
Washington, DC 20554

Re: Fusion Lighting, Inc.
ET Docket No. 98-42
Our File 07330/008001

Dear Ms. Salas:

I am enclosing recent correspondence for the above-referenced file.

Very truly yours,

Terry G. Mahn

/seg
Enclosure/Original & Copy

cc: Service List

98286.W11

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Washington, DC 20005

Telephone
202 783-5070

Facsimile
202 783-2331

Web Site
www.fr.com

Frederick P. Fish
1855-1930

W.K. Richardson
1859-1951

May 19, 1999

Mitchell Lazarus, Esq.
Fletcher Heald & Hildreth, P.L.C.
1300 North 17th Street, 11th Floor
Rosslyn, VA 22209-3801

Re: Our File 07330/008001

Dear Mitch:

BOSTON
NEW YORK
SILICON VALLEY
SOUTHERN CALIFORNIA
TWIN CITIES
WASHINGTON, DC

I am enclosing herewith a technical analysis and current conclusion of Fusion Lighting, Inc. as to your letters of March 2nd and April 12th.

It appears to Fusion that neither proposal is practical. The first proposal, which you describe as "inflicting serious levels of interference on LAN receivers", is 100 times (40 dB) more stringent than current technology allows; it would preclude a lighting product of any commercial value. The alternative, because of its frequency location and narrow bandwidth, precludes any magnetron-driven lighting product although the magnetron is the indispensable driver for RF lighting today.

Taking the declared spectrum needs of the Part 15 Interests at face value, Fusion is prepared to conclude that RF lighting and low-power wireless cannot exist compatibly in the same spectrum space. If the FCC adopts your proposal, it will drive Fusion from the magnetron-driven RF lighting business. Accordingly, the Part 15 Interests must relocate their systems to another ISM band, acquire licensed spectrum elsewhere, or modify their technology so as to avoid interference from Fusion lamps.

Now that the Part 15 Interests have clearly stated their needs and objectives, it is also clear that it is contrary to law and against public policy for them to certify and to market their devices, which they know create spectrum conflicts for senior authorized users of the ISM band at 2450 Hz. This has put, and increasingly will put, users in the untenable position of having to choose between products which have band priority by law and unlicensed devices which do not. Such behavior is illegal. If, with the information now available to it, the FCC continues to tolerate such behavior or acts to protect it, Fusion will assert the fundamental Constitutional issues and significant questions of law and spectrum policy that have emerged. These likely will take years to resolve and will cloud our clients' respective businesses indefinitely.

Fusion maintains an open mind and the hope that there may yet be some opportunity to resolve these emerging issues. Fusion would be willing to meet again with representatives of the Part 15 Interests to discuss both the technical issues and the broader business implications. I suggest that we schedule something within the next week to ten days, and look forward to your response.

I am sending a copy of this letter and the attachment to the Commission for the public record because the material to which it responds was so disseminated.

Very truly yours,

Terry G. Mahn

/seg
Enclosure
cc: Fusion Lighting, Inc.
Service List

98159.W11

SERVICE LIST

Chairman William E. Kennard
Federal Communications Commission
445-12th Street, S.W.
Room 8-B201
Washington, DC 20554

Mr. Ari Fitzgerald
Office of Chairman Kennard
Federal Communications Commission
445-12th Street, S.W.
Room 8-B201
Washington, DC 20554

Commissioner Susan Ness
Federal Communications Commission
445-12th Street, S.W.
Room 8-B115
Washington, DC 20554

Mr. Daniel Conners
Office of Commissioner Ness
Federal Communications Commission
445-12th Street, S.W.
Room 8-B115
Washington, DC 20554

Commissioner Harold Furchgott-Roth
Federal Communications Commission
445-12th Street, S.W.
Room 8-A302
Washington, DC 20554

Mr. Paul Misener
Office of Commissioner Furchgott-Roth
Federal Communications Commission
445-12th Street, S.W.
Room 8-A302
Washington, DC 20554

Commissioner Michael K. Powell
Federal Communications Commission
445-12th Street, S.W.
Room 8-A204
Washington, DC 20554

Mr. Peter Tenhula
Office of Commissioner Powell
Federal Communications Commission
445-12th Street, S.W.
Room 8-A204
Washington, DC 20554

Commissioner Gloria Tristani
Federal Communications Commission
445-12th Street, S.W.
Room 8-C301
Washington, DC 20554

Ms. Karen Gulick
Office of Commissioner Tristani
Federal Communications Commission
445-12th Street, S.W.
Room 8-C301
Washington, DC 20554

Mr. Julius P. Knapp
Chief, Policy and Rules Division
Office of Engineering and Technology
Federal Communications Commission
2000 M Street, N.W.
Suite 480
Washington, D.C. 20554

Ms. Karen Rackley
Chief, Technical Rules Branch
Office of Engineering & Technology
Federal Communications Commission
2000 M Street, N.W.
Suite 480
Washington, D.C. 20554

David C. Jatlow, Esq.
Young & Jatlow
1150 Connecticut Avenue, NW
Suite 420
Washington, DC 20036

Larry Solomon, Esq.
Shook, Hardy & Bacon L.L.P.
Hamilton Square
600 14th Street, NW
Suite 800
Washington, DC 20005-2004

Fusion Lighting, Inc. May 17, 1999

FCC ISM ISSUES

Background

Longstanding and well-settled FCC Rules clearly establish RF lighting as a senior authorized user of the ISM band at 2450 MHz, permit unlimited emissions within the band and mandate that wireless communications accept any interference from RF lighting. Fusion Lighting, Inc. ("Fusion") is the sole supplier of such RF lighting systems for general illumination, systems that are expected to become ubiquitous. The equipment is governed by Part 18 of the FCC rules.

Companies including Intel, IBM, Ericsson, Nokia, Toshiba, Lucent Technology, Compaq Computer, Dell, Motorola, and Harris Corporation have now declared that they wish to saturate the market with low-power wireless communications systems and services operating in the same band. The band attracts them because it is free and because it is global, two artifacts of its creation long ago by international treaty and its reservation largely for non-communications usage ever since. The equipment is governed by Part 15 of the FCC Rules.

RF lighting necessarily operates continuously and at high power in order to maximize electrical efficiency and useful light output, two of the most market-relevant measures of lighting products. Wireless communications receivers, however, must discern the relatively low power signals that they seek from all other signals that may be present. Since signals at high power assuredly will interfere with proximate signals at low power in the same spectrum, wireless proponents now seek to eliminate or radically curtail RF lighting systems under the FCC Rules or otherwise.

On December 1, 1998, some of the wireless proponents asked the Commission to limit RF lighting emissions within the band to 1 millivolt per meter at 3 meters (indoors) and 10 millivolts per meter at 3 meters (outdoors). That is about the level of electromagnetic noise when RF lighting is absent. It would fully protect the subordinate wireless user from interference by the senior RF lighting user, and would instantly and completely overturn the long history of Commission rulings and directives to the opposite effect. "Spectrum cleansing" is what Fusion calls it.

That request was amended on December 23, 1998, the wireless proponents saying that although some interference would result a tolerable limit would be 20 millivolts per meter at 3 meters. They did not distinguish indoor equipment from outdoor.

On January 14, 1999, Fusion and some of the wireless proponents met to begin to explore the possibilities for compromise. Fusion requested a statement of the minimum spectrum needs of the relevant technologies and a technical understanding of those requirements. On March 2nd, Fusion received a somewhat modified proposal for limitations on RF

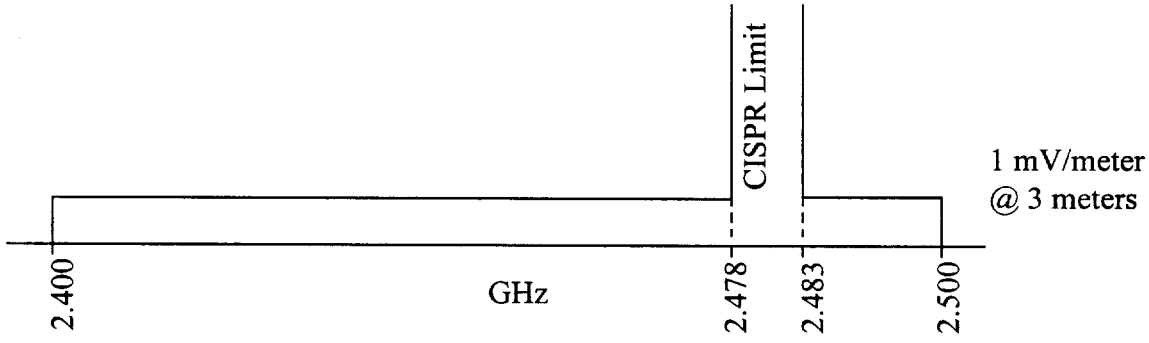
lighting emission and supporting technical discussion. On March 12th, Fusion requested clarification of six substantive points, including such fundamentals as whether proposed limits on RF lighting emissions were to be measured at peaks or as averages. Fusion received partial answers on April 12th.

Current Proposals

Fusion has carefully reviewed the proposal dated March 2nd in which some of the wireless proponents seek to limit RF lighting emission in the ISM Band at 2450 MHz. It has studied the supporting technical discussion with equal care, and it has tested numerous configurations of microwave-powered lamps for such RF lighting systems at an independent testing laboratory in order to acquire current data as an aid to evaluation.

The current proposal is in two parts, one alternative to the other. The first seeks to allow both RF lighting and Part 15 devices to use the entire ISM Band, but would limit RF lighting emissions to a peak of 20 millivolts per meter at 3 meters, just as proposed to the Commission on December 23rd. It is said that such emissions by RF lighting would in fact hinder Part 15 operations, but tolerably so.

Alternatively, the wireless proponents would separate Part 15 devices and RF lighting by allocating priority as to 78.5 MHz of bandwidth to Part 15 devices, priority as to 5 MHz of bandwidth to RF lighting, and priority as to the remaining 16.5 MHz of bandwidth to mobile satellite service. The proposed priority of RF lighting would apply from 2478.5 MHz to 2483.5 MHz. Within that 5 MHz range, RF lighting emissions would be limited as per current CISPR rules for lighting in the ISM Band. Outside that range, RF lighting emissions would be limited to a peak of 1 millivolt per meter at 3 meters, just as was initially proposed to the Commission. See Figure 1 below.



Alternative
Figure 1

Conclusion

Neither proposal works. Part 15 wireless systems as designed apparently cannot function in the same physical neighborhood with Part 18 RF lighting, let alone in the same building. A typical RF lighting system would have to be half a mile or more from the nearest Part 15 device to meet the first standard. Under the second standard, a typical RF lighting system could not operate at all. The proposed standards – combined with the proposed change of FCC measurement methodology from averages to peaks -- would limit RF lighting emission to one percent of what current technology can achieve. Fusion's RF lighting program could not survive.

Fusion would not arbitrarily reject "minimal safeguards for continued use of the spectrum already available to them under FCC rules", as a representative of some of the wireless proponents has called their proposals. But those proposals in fact would eliminate Fusion's historical and existing priority to fully develop RF lighting applications in the band, and would make any certifiable RF lighting product entirely unmarketable. The wireless proponents have designed communications systems that require a priority in spectrum which can be acquired only at Fusion's expense.

Review of Proposal 1

RF lighting is based upon a unique combination of Fusion's proprietary bulb fill and electrodeless lamp technology and the magnetron that is made for mass market microwave ovens. The microwave oven magnetron is the world's only fully developed low cost source of high power RF energy. These devices are manufactured in volumes of tens of millions per year and sell for less than twenty dollars each. Fusion has shown that standard cooker magnetrons can provide a service life of over 20,000 hours in a properly designed electrodeless lamp. DC to RF conversion efficiencies of 65% to 70% are achievable. In contrast, practical solid state RF sources at this frequency and power level do not exist. Experimental solid state circuitry necessary to achieve the required RF power costs thousands of dollars, offers poor efficiency and uncertain reliability.

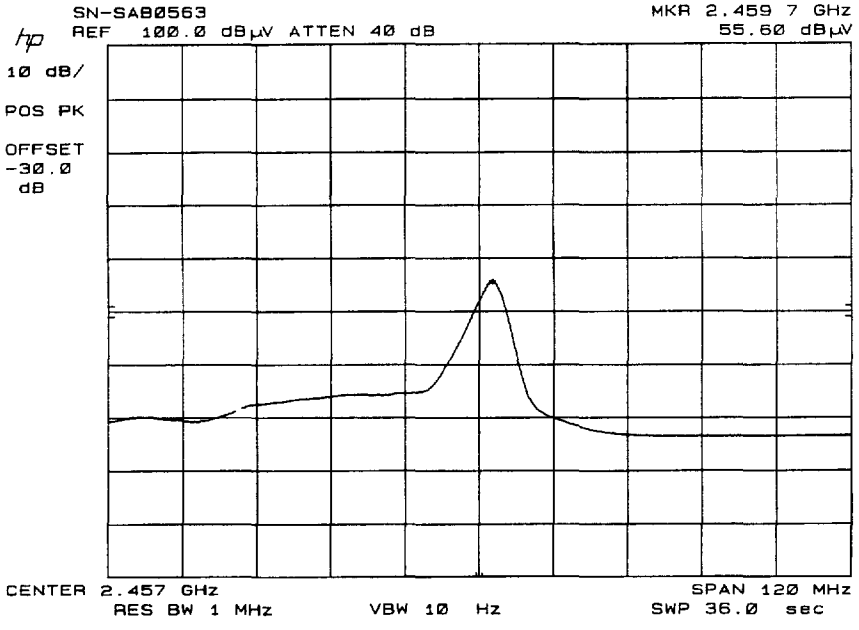
For the foreseeable future, general lighting with RF lamps will be based upon microwave oven style magnetrons. The RFI characteristics of RF lamps are essentially established by the magnetron. Fusion has no control over the specification of the magnetron. Furthermore, Fusion is not aware of any modifications to the magnetron that would materially affect the RF emission signature of these devices. Fusion takes great care to ensure that the magnetron and lamp are properly tuned to a matched load condition and are properly RF shielded with a primary screen plus a secondary RF barrier consisting of a metal reflector and an ITO coated cover glass. These state-of-the-art practices ensure that all lamps are in full compliance with existing regulatory requirements.

Representative Fusion lamps were measured at PCTEST Engineering Laboratory in Columbia, Maryland. Lamps using magnetrons powered by both ferroresonant and DC

switching power supplies were evaluated. RF emission measurements were obtained with two video bandwidth filters, 1 MHz and 10 Hz. It should be noted that the accepted FCC protocol for EMI measurements of Part 18 RF lighting devices is based on a video bandwidth of 10 Hz. (See the FCC memo attached.)

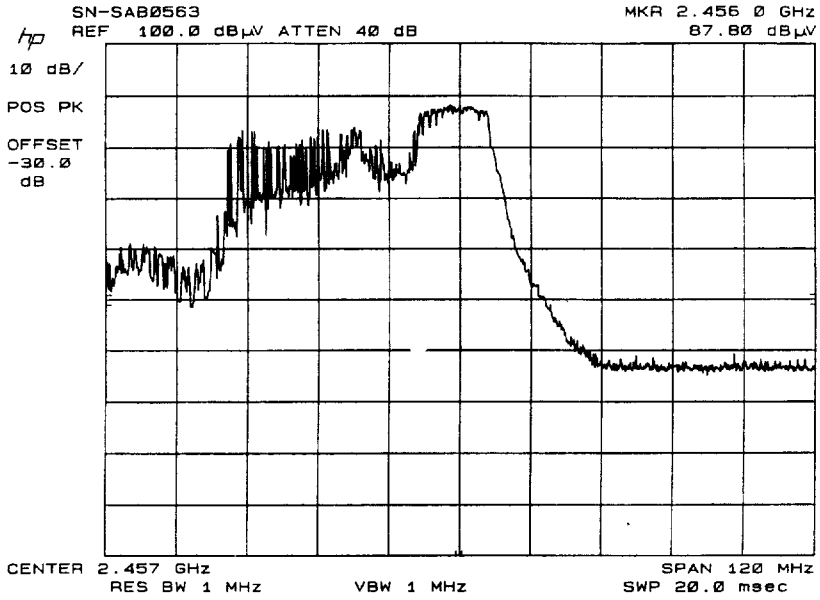
Six lamps were randomly removed from life test. These lamps were powered by ferroresonant style power supplies with full wave rectification. The operating life of some exceeded 20,000 hours, and others were relatively new. All were equipped with a fully functional primary screen, a reflector, and a cover glass with an electrically conductive coating.

The detection antenna was placed at three meters in front of the reflector and positioned to obtain maximum readings. When measured with the 10 Hz video filter, mean average field strength for this group of six lamps was 37 mV/meter at 3 meters. No lamp passed the proposed 20 mV/meter peak limit. Figure 1 presents a typical scan from this set of measurements. It should be pointed out that the optical reflector on the lamp acts as a directional antenna, generating approximately 6 db of gain; reflectors of other shapes and sizes will generate different and in some cases significantly higher levels of gain. Signal gains of 20db are to be expected.



Ferroresonant Lamp Measured with 10 Hz Filter
AFCL=33.47 db
Figure 2

The 10 Hz filter was switched to a 1 MHz filter to obtain peak measurements. Utilizing this technique, the mean peak measurement for the same group of six lamps rose to 1,959 mV/meter at 3 meters. Figure 2 shows the same lamp as was presented in figure 1 with RFI measurements taken with the 1 MHz filter.

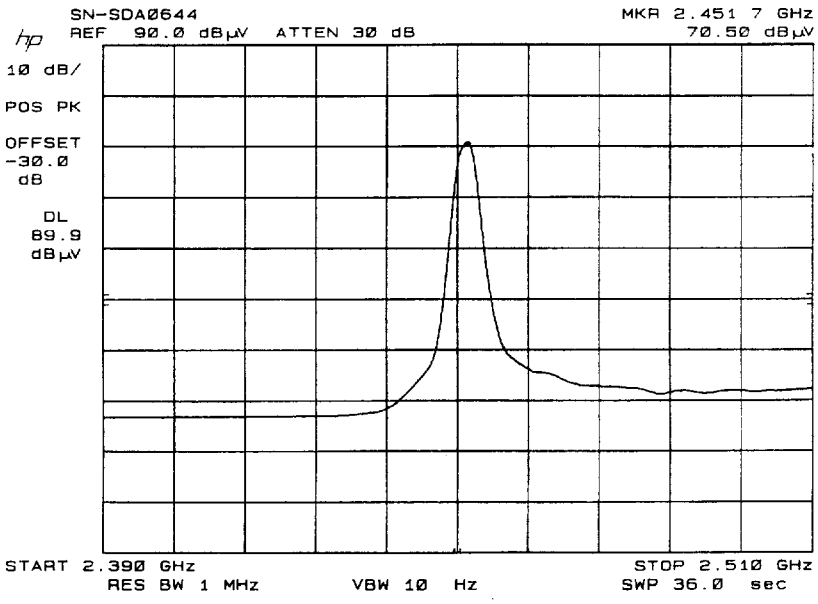


Ferroresonant Lamp Measured with 1 MHz Filter
AFCL=33.47 db
Figure 3

The first of Fusion's March 12th questions was designed to clarify the assumptions made by the Part 15 Interests as to the measurement protocol and video bandwidth implied in the proposed specifications. In their reply of April 12th a resolution bandwidth of 5 MHz is requested. This indicates that a peak measurement is proposed rather than the average which is called for by FCC guidelines. With this information, it is clear that this group of lamps, which fully meet today's FCC requirements, would fail the proposed in-band limits by a factor of one hundred (40db). A Part 15 Device would, on average, need to be kept a half mile or more from the front of a typical lamp to avoid peak RFI levels greater than 20mV/meter.

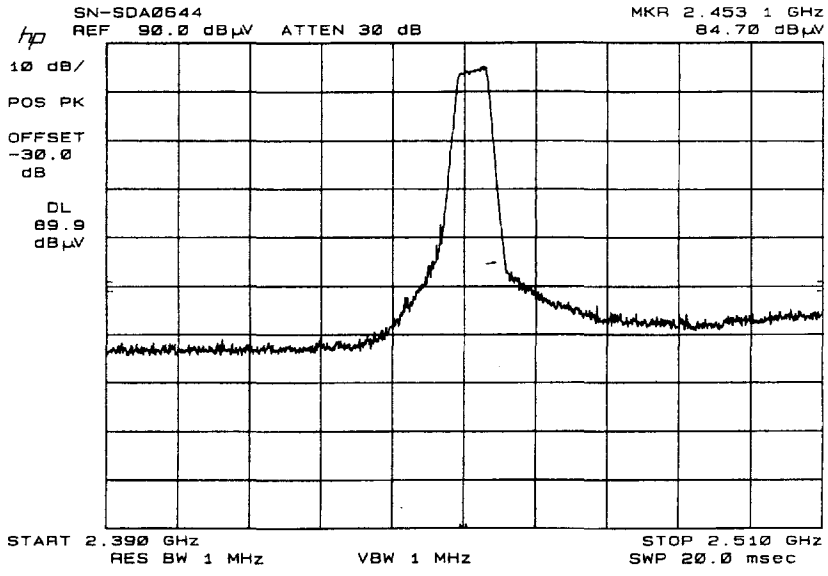
These lamps did readily meet the specification set by the United States Food and Drug Administration, which is 1 mW/cm^2 for unrestricted exposure. When RF leakage was measured, these lamps yielded peak readings under 0.1 mW/cm^2, or 10% of the allowable level.

A second group of six lamps was returned from field testing for this study. They use an experimental solid-state switching power supply that applies low ripple DC current to the magnetron. When measured with the 10 Hz video filter, the mean average field strength for this group of lamps was 195 mV/meter at 3 meters. Again, no lamp passed the 20 mV/meter at 3 meters limit. Figure 3 presents a typical scan of this data.



Lamp with Switching Power Supply Measured with 10 HZ Filter
AFCL=33.47 db
Figure 4

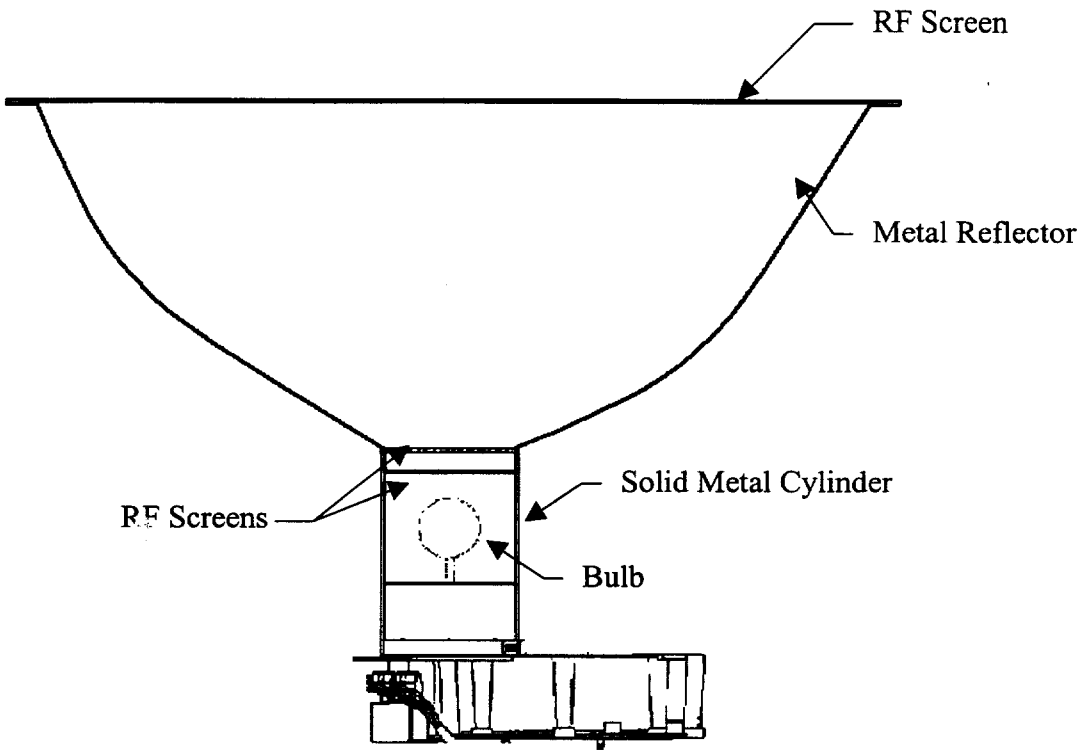
When the 10 Hz filter was replaced with the 1 MHz filter, the average peak measurement for this group of lamps increased to 883 mV/meter at 3 meters. Scans for a representative lamp from this group are shown below in Figure 4. These lamps would fail the proposed in-band limit by a factor of nearly fifty (34db).



Lamp with Switching Power Supply Measured with 1 MHz Filter
AFCL=33.47 db
Figure 5

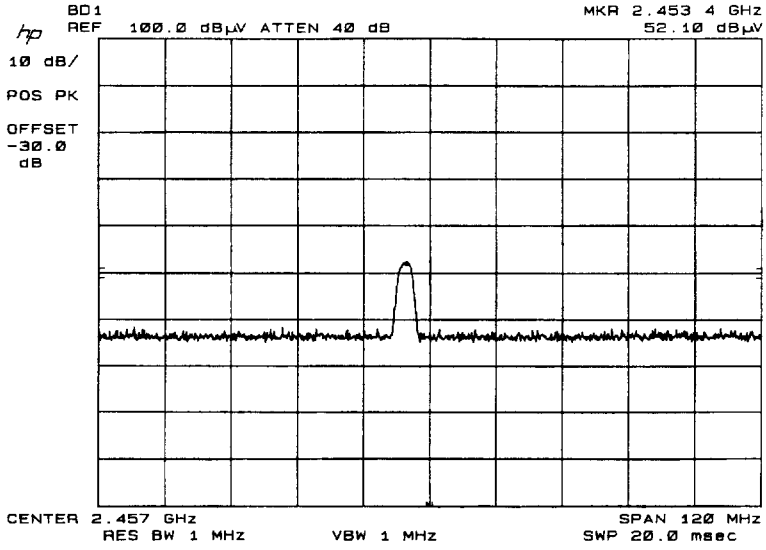
RF power measurements were also taken on this group of lamps. Again, the maximum RF leakage was less than 0.1 mW/cm^2, 10% of the allowable.

A special lamp was constructed to determine if by heroic means it could meet the proposed 20mV/meter at 3 meter limit. It incorporated a solid metal cylinder around the bulb. Light was emitted only through the top of the cylinder. A series of well designed RF attenuating screens was placed over the top of the cylinder. See Figure 5. On a peak measurement basis, the proposed 20mV/meter at 3 meter limit was achieved only with the addition of three separate RF attenuation screens. See Figure 6. While such a device may have met the proposed EMI specification, the output of useful light was halved, rendering the lamp completely noncompetitive.



Special lamp with 3 RF screens

Fig. 6



RF Emissions of Special Test Lamp

AFCL=33.47 db

Figure 7

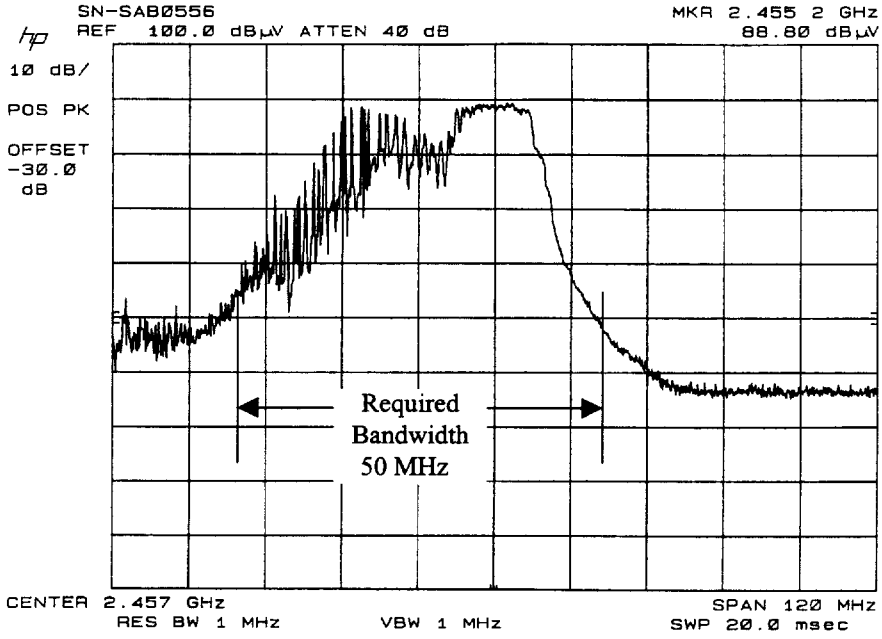
If Part 15 devices in fact require the freedom from interference that is implied by the proposed standard and supporting technical discussion, then current technology RF lighting devices and current technology Part 15 devices cannot coexist in the same spectral space.

Review of Proposal 2

Proposal 2 would separate RF lighting and Part 15 communications by giving each priority within a portion of the 2450 MHz ISM band. This proposal allocates 78.5 MHz of bandwidth to Part 15 interests, 5 MHz of bandwidth to RF lighting, and 16.5 MHz of bandwidth to mobile satellite service. The proposed RF lighting band would reside at frequencies from 2478.5 MHz to 2483.5 MHz. This proposal further sets out of band limits within the ISM band for RF lighting at 1 mV/meter at 3 meters. See Figure 1 above.

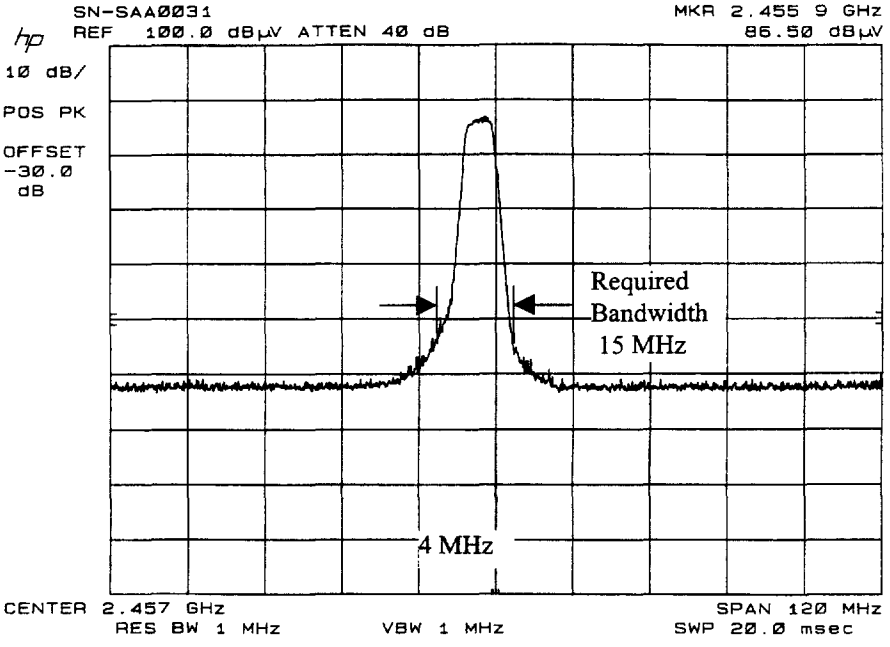
Magnetrons are the only cheap, efficient, reliable and widely available source of high power RF energy in RF lighting. They are produced in the millions for microwave ovens, and there is no commercially practical alternative. The center operating frequency for commodity magnetrons mated with RF lamps varies over a range of 2445 MHz to 2460 MHz. This range of center frequencies does not match the proposed priority band for RF lighting band. Fusion does not control the makers of such magnetrons and cannot compel them to shift center frequency or ensure that they will produce magnetrons in any particular range of center frequencies over time.

Further, the bandwidth requirements for RF lighting must also accommodate the fact that the center frequency of a magnetron shifts over the lifetime of the device. Frequency shifts of 3 to 4 MHz are considered normal. Even if the center frequency of the magnetron could be precisely predicted and controlled, the proposed bandwidth allocation for RF lighting would not be sufficient. Fig. 8 illustrates the spectral distribution for a lamp powered by a full wave ferroresonant power supply. The ferroresonant power supply is today's only market-ready power supply. It has proven reliability and is several hundred dollars less expensive than the solid state switching power supplies that are still under development.



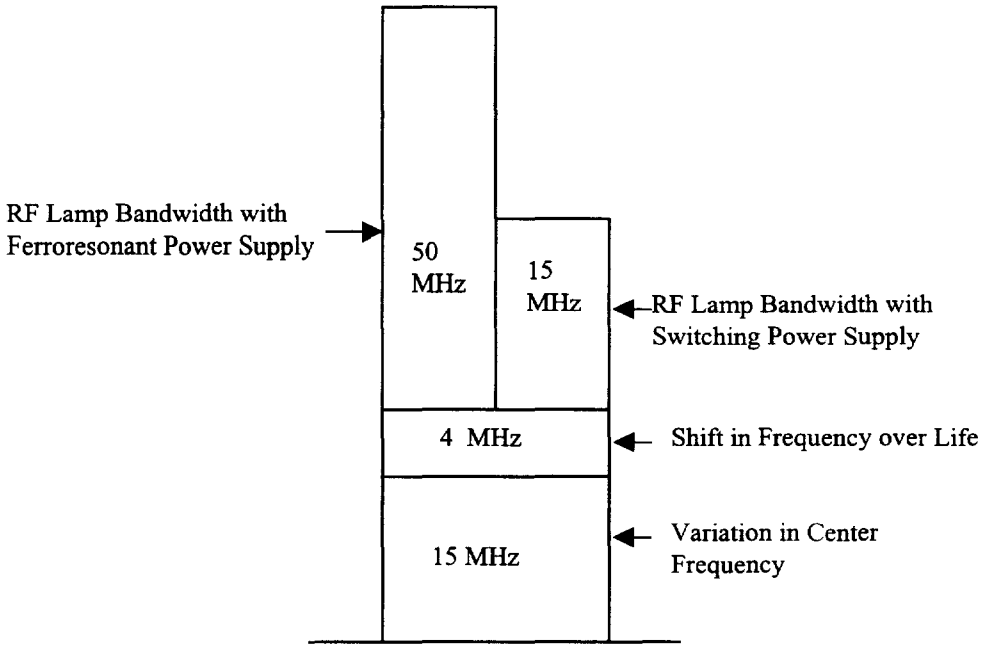
Ferroresonant Lamp Measured with 1 MHz Filter
AFCL=33.47 db
Figure 8

Data showing the RF spectral distribution for a lamp powered by an experimental low ripple solid state DC switching power supply is presented in Figure 9. Again, the bandwidth necessary for RF lighting exceeds the proposed allocation of 5 MHz.



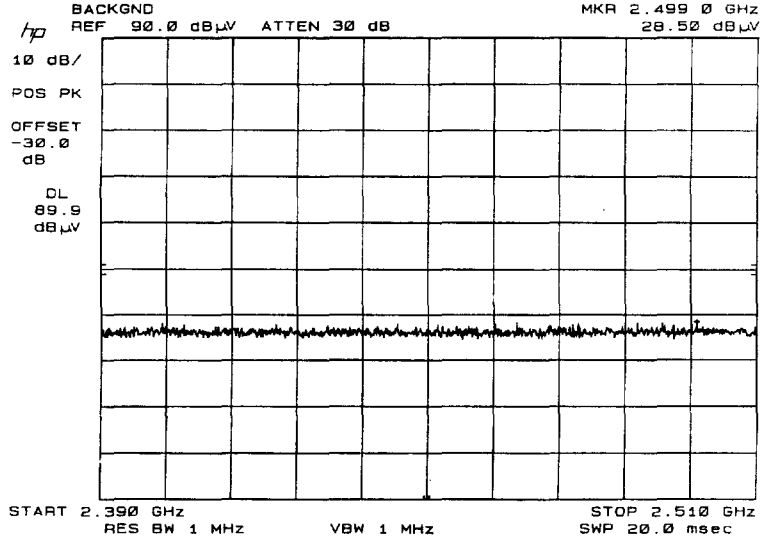
Lamp with Switching Power Supply Measured with 1 MHz Filter
AFCL=33.47 db
Figure 9

Using the data taken with the 1 MHz filter, one can estimate the bandwidth required for RF lighting devices. This is shown in Figure 10 as the "stacked" effect of several variables. The conclusion is that RF lamps powered by a ferroresonant power supply require a minimum bandwidth of 69 MHz. RF lamps powered by a switching power supply would require a minimum bandwidth of 34 MHz, if such power supplies can be developed to appropriate commercial standards of cost and reliability.



Bandwidth Required for RF Lighting
Figure 10

Fusion's attempt to explore the proposed out-of-band limit of 1 mV/meter at 3 meters was unsuccessful. Even with all RF lighting devices turned off, the background electromagnetic noise level at the independent testing laboratory was measured to be approximately 1 mV/meter.



Background RF measured at PCTEST
Fig. 11

The adoption of proposal 2, either alone or in combination with proposal 1, is not compatible with an ongoing RF lighting business.

FEDERAL COMMUNICATIONS COMMISSION

Customer Service Branch
7435 Oakland Mills Road, Columbia, MD 21046
Phone: (301) 362-3042, Fax: (301) 3442050
E-mail: rlaforge@fcc.gov www site:http://www.fcc.gov
FROM: Ray LaForge **DATE:** March 5, 1999
TO: Michael Ury
PAGES: 1
REFERENCE: Your inquiry

Dear Mr. Ury:

In regard to your questions the following response is provided:

The Commission has established a policy for measurements taken above 1 GHz using a spectrum analyzer wiht a resolution bandwidth of 1 MHz and a Video bandwidth of 10 Hz to produce an average field strength value for EMI measurements. Originally, we accepted this method for AM and spread spectrum measurements. However, in order to be consistent we now also accept this procedure for other types of systems including FM and the type of modulation typically used in RF lighting. Be sure to take the measurements in "linear mode" as set on the test equipment.

I hope this is responsive to your inquiry. If you have any further questions, please don't hesitate to call.

Ray LaForge
FCC-OET
Customer Service Branch